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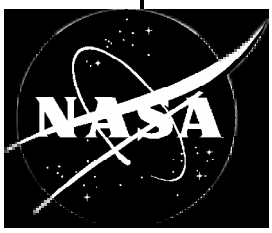
MISSION OPERATIONS AND DATA SYSTEMS DIRECTORATE

Interface Control Document (ICD) Between the Earth Observing System (EOS) Data and Information System (EOSDIS) Backbone Network (EBnet) and Spacecraft Checkout Station (SCS)

September 1997



National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

Interface Control Document (ICD) Between the Earth Observing System (EOS) Data and Information System (EOSDIS) Backbone Network (EBnet) and Spacecraft Checkout Station (SCS)

September 1997

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Preface

This document is under the configuration management of the National Aeronautics and Space Administration (NASA) Communications (Nascom) Division Configuration Control Board (CCB).

Proposed changes to this document shall be submitted to the Nascom CCB, along with supportive material justifying the change. Changes to this document shall be made by Document Change Notice (DCN) or by complete revision.

Questions concerning this document and proposed changes shall be addressed to:

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Abstract

This Interface Control Document (ICD) describes interface agreements between the Spacecraft Checkout Station (SCS) and Earth Observing System (EOS) Data and Information System (EOSDIS) Backbone Network (EBnet).

Keywords: *Earth Observing System Data and Information System Backbone Network, EBnet, ICD, Interface Control Document, SCS, Spacecraft Checkout Station*

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Abbreviations and Acronyms

Section 1. Introduction

1.1 Authority and Responsibility

The Mission Operations and Data Systems Directorate (MO&DSD) has the authority to implement Earth Observing System (EOS) Data and Information System (EOSDIS) Backbone Network (EBnet). This authority was granted to the MO&DSD by the EOS project, under the Office of Mission to Planet Earth (Code Y). The EBnet project is under the National Aeronautics and Space Administration (NASA) Communications (Nascom) Division of the MO&DSD.

Code 540 will provide an operational communications network to support high-speed network communications between EBnet and non-EBnet hosts. The primary responsibility for this project has been assigned to the Nascom Division, Code 540. The system requirements are documented by the references in Section 2.1.

1.2 Purpose

The purpose of the interface between the Spacecraft Checkout Station (SCS) and EBnet is to support connectivity between the SCS and EOS Data and Operations System (EDOS) as well as connectivity between SCS and EOSDIS Test System (ETS). The SCS data flows require a Nascom clock and data service. This interface supports early checkout testing in lieu of using a Tracking and Data Relay Satellite System (TDRSS) service. This interface is not considered to be mission critical. The SCS is located at Valley Forge, Pennsylvania (VFPA) initially and is then moved to Vandenberg Air Force Base (VAFB) for launch processing support. While at VAFB, the SCS only requires connectivity to EDOS. It is assumed that no connectivity to the ETS is required while the SCS is at VAFB. It is important to note that the clock and data service from VFPA supporting the SCS is shared on a non-interference basis with the Spacecraft Simulator (SSIM).

1.3 Scope

This Interface Control Document (ICD) defines and controls the functions, communications protocol(s), frame formats, and electrical characteristics of the interfaces between EBnet-provided equipment, software, and communications paths and other entities that directly interface with the network. Interfaces provided by Nascom are included in the scope of this document. Interfaces between EBnet users and other systems not provided by Nascom are not within the scope of this document.

1.4 Time Frame

This ICD shall be in effect from the date of the last approval signature.

1.5 Goals and Objectives

The goals of EBnet are to:

a. Implement an operational, integrated, transparent communications system that serves the data communications needs of projects supported by NASA Goddard Space Flight Center (GSFC), and users outside the MO&DSD.

b. Expand using industry standard system solutions while maintaining compatibility with the existing network and user interfaces.

c. Minimize costs for implementation, operation, and maintenance of the network.

d. Minimize life-cycle costs.

e. Maintain high availability by designing with redundancy, and without single points of failure in the Network Backbone, where required.

f. Utilize state-of-the-art technology, utilizing equipment with the best price-performance available commercially.

g. Allow for growth, adaptability to changing requirements, infusion of new technology, and upgraded interfaces throughout the life-cycle.

1.6 Standards Precedence

EBnet will be based on Government, commercial, and international standards. In case of conflict, the following precedence (in descending order) applies:

- This EBnet ICD.
- Government standards.
- Commercial and/or international standards.

1.7 Document Organization

Section 2 contains parent, applicable, and reference documents related to this ICD.

Section 3 details a systems overview of the EBnet, SCS, and the interrelationship.

Section 4 presents an interface detailed design.

Section 5 describes the facilities and maintenance demarcation.

A list of abbreviations and acronyms is provided at the end of the document.

Section 2. Related Documentation

2.1 Parent Documents

[1] *Earth Observing System AM-1 Detailed Mission Requirements*, Goddard Space Flight Center (GSFC), 505-10-33, November 1996

[2] *Earth Science Data Information System (ESDIS) Project Level 2 Requirements Volume 6, EOSDIS Backbone Network (EBnet) Requirements*, Goddard Space Flight Center (GSFC) 505-10-01-6, Revision A, December 1996

[3] *Earth Observing System (EOS) Data and Information System (EOSDIS) Backbone Network (EBnet) Interface Requirements Document (IRD)*, September 1997

[4] Reserved

2.2 Applicable Documents

[5] *Electrical Characteristics of Balanced Voltage Digital Interface Circuits*, Electronic Industries Association (EIA) 422-A, December 1978

[6] *General-Purpose 37-Position and 9-Position Interface for Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange*, EIA 449, November 1977

[7] *Internet Protocol (IP): DARPA Internet Program Protocol Specification*, Request for Comment (RFC) 791, September 1981

[8] *The Point-to-Point Protocol (PPP)*, RFC 1661, July 1995

[9] *An Ethernet Address Resolution Protocol or Converting Network Protocol Addresses to 48-bit Ethernet Addresses for Transmission on Ethernet Hardware*, RFC 826, November 1982

[10] *Internet Control Message Protocol*, RFC 792, September 1981

[11] *Routing Information Protocol (RIP)*, RFC 1058

[12] *Open Shortest Path First (OSPF)*, RFC 1247

[13] *Internet Group Multicast Protocol (IGMP)*, RFC 1112

[14] *On the Assignment of Subnet Numbers*, RFC 1219

[15] *Simple Network Management Protocol (SNMP)*, RFC 1157

[16] (reserved)

[17] *A Reverse Address Resolution Protocol (RARP)*, RFC 903

[18] *Internet Protocol on Ethernet Networks*, RFC 894

[19] *Transmission of IP over FDDI*, RFC 1188

[20] *Structure of Management Information*, RFC 1155

[21] *Management Information Base - II*, RFC 1213

[22] *Transmission Control Protocol*, RFC 793

[23] *Telnet Protocol*, RFCs 854 & 855

[24] *File Transfer Protocol*, RFC 959

[25] International Organization for Standardization (ISO) 9314-1, *FDDI Physical Layer Protocol (PHY)*

[26] ISO 9314-2, *FDDI Media Access Control (MAC) Protocol*

[27] ISO 9314-3, *FDDI Physical Layer Medium Dependent (PMD)*

[28] ISO 8802-2, *Logical Link Control (LLC)*

[29] ISO 8802-3, *Carrier-Sense Multiple-Access with Collision Detection (CSMA/CD) Media Access Control (MAC) - Ethernet version 2*

[30] Institute of Electrical and Electronic Engineers (IEEE) 802.3 *10Base-T (twisted pair)*

[31] IEEE *10Base5 (thick ethernet)*

[32] International Telegraph and Telephone Consultative Committee (CCITT) *V.35*

2.3 Reference Documents

[33] *NASA Communications (Nascom) Access Protection Policy and Guidelines*, 541-107, Revision 3, GSFC, November 1995

[34] *NASA Communications System Acquisition and Management*, NASA Management Instruction (NMI) 2520.1D, National Aeronautics and Space Administration (NASA), November 18, 1991

[35] *Nascom IONET Users Guide*, 541-225, Revision 1, April 1996

[36] *Interface Requirements Document between the Earth Observing System Data and Information System (EOSDIS) and the AM Project for AM-1 Flight Operations*, 505-41-15, GSFC, July 1995

[37] *Interface Control Document (ICD) Between the Earth Observing System (EOS) Data and Information System (EOSDIS) Backbone Network (EBnet) and Spacecraft Simulator*, 540-092, July 1997

Section 3. Systems Overview

3.1 EBnet General System Description

The EBnet provides wide-area communications circuits and facilities between and among various EOS Ground System (EGS) elements to support mission operations and to transport mission data between EOSDIS elements. The relationship of EBnet to other elements supporting EOS is shown in Figure 3-1. EBnet is responsible for transporting spacecraft command, control, and science data nationwide on a continuous basis, 24 hours a day, 7 days a week. The EBnet capability to transport these diverse types of data is implemented as two distinct subnetworks referred to as "real-time" and "science" networks. The real-time network transports mission-critical data related to the health and safety of on-orbit space systems and raw science telemetry as well as pre-launch testing and launch support. This highly redundant network provides an operational availability of 0.9998 with a Mean Time to Restore Service (MTTRS) of 1 minute. The science network transports data collected from spacecraft instruments and various levels of processed science data including expedited data sets, production data sets, and rate-buffered science data. The science network provides an operational availability of 0.98 with a MTTRS of 4 hours.

EBnet provides three options for accessing the Internet Protocol (IP)-based EBnet transport service: Local Area Network (LAN) Ethernet, LAN Fiber Distributed Data Interface (FDDI), and Wide Area Network (WAN) carrier service. Figure 3-2 shows an example of each of these types of interface/demarcation points to EBnet users. Additionally, EBnet will support serial clock and data interfaces with the user system as is the case with the SCS interface. This ICD describes the EBnet/SCS interface which employs serial clock and data only.

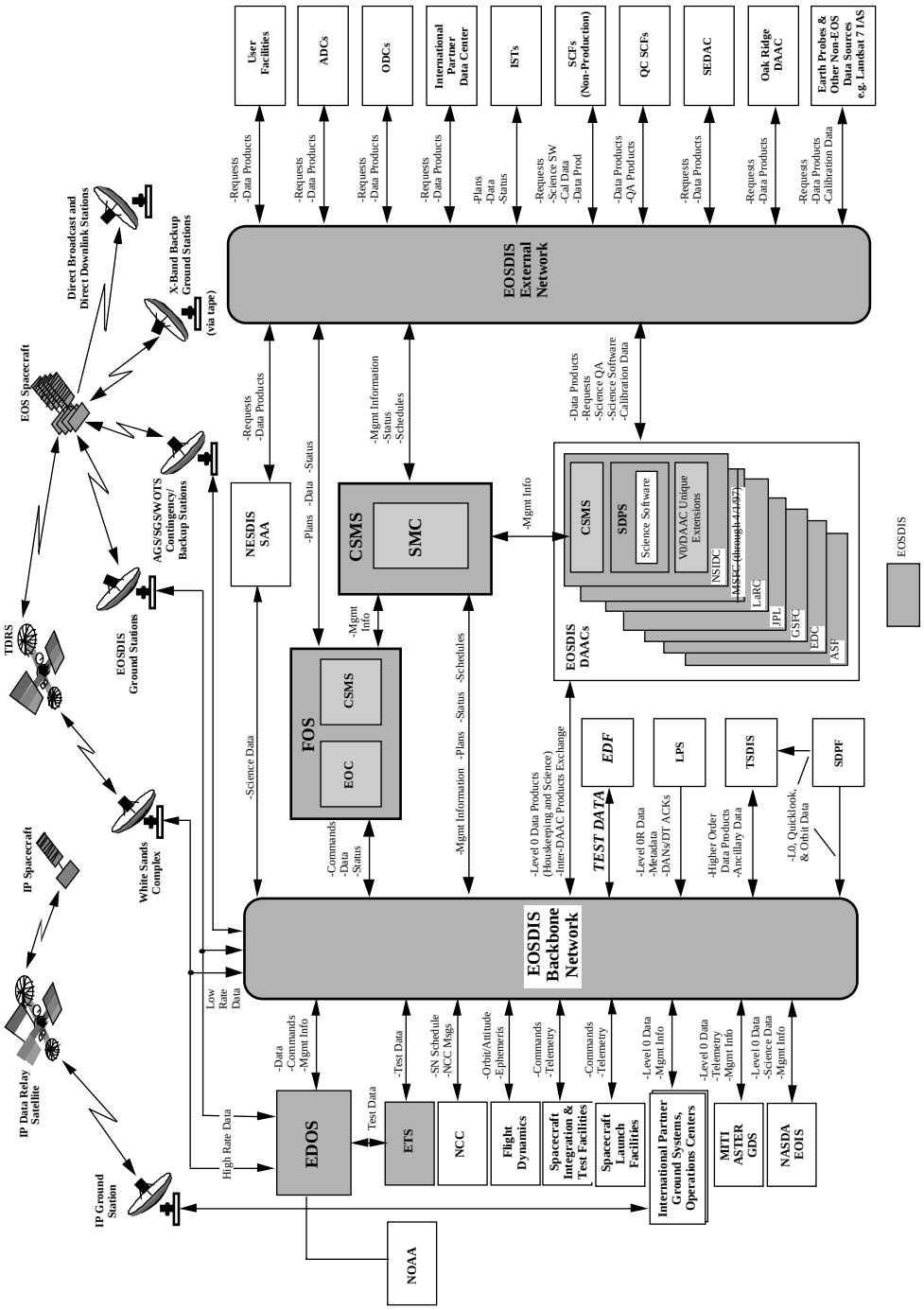

Figure 3-1. EOS Ground System

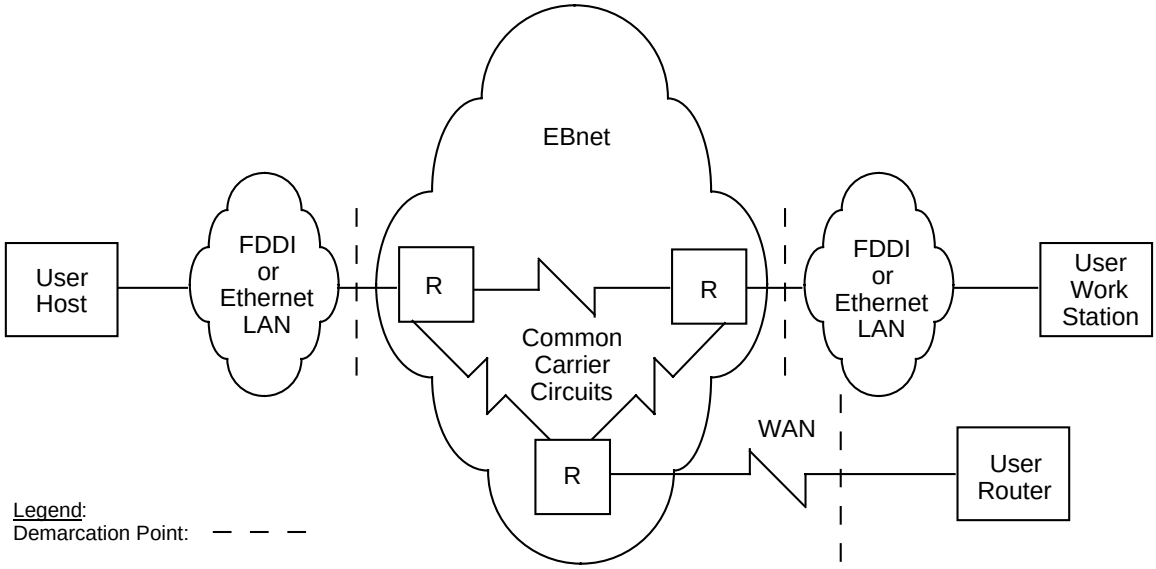

Figure 3-2. EBnet Demarcations

Sustaining engineering, preventive and remedial maintenance, and network monitoring services are provided for EBnet equipment, to ensure that EBnet keeps pace with technology and standards, and provides continuous service. The official point of contact for EBnet operational status is the Nascom Communications Manager (COMMGR) (301-286-6141). Users who detect a network problem are urged to immediately report it to the COMMGR. The COMMGR may also provide users with limited information about maintenance and status actions. Refer to the Nascom IP Operational Network (IONET) User Guide (541-225) for information regarding user connections, security guidelines, and maintenance information.

3.2 SCS Description

The SCS is initially located at the Lockheed Martin (LM) contractor's facility in VFPA. The function of this workstation is to verify the performance of the AM-1 spacecraft in the factory and later at the launch facility during prelaunch operations at VAFB. The SCS is shown in detail in the following sections detailing the interface design.

3.3 Relationship Between EBnet and SCS

EBnet provides the transport media for the transmission of operational data between the EDOS at GSFC and the SCS for the purpose of testing and verifying the AM-1 satellite. Initially, the SCS will be located at the LM contractor's facility in VFPA. When the spacecraft is relocated to the VAFB launch site, the SCS and its EBnet communication terminal will be relocated with it.

Section 4. Interface Detailed Design

4.1 Interface Design Overview

EBnet/SCS interface design is based on the requirement to transport three variable-rate data streams on three discreet serial clock and data channels between the SCS and the EOS Operations Center (EOC). EBnet has selected a Timeplex T1 multiplexer (MUX) to transport digital signals to and from the SCS. Figure 4-1 provides an end-to-end depiction of the circuit between the SCS and GSFC. The launch site interface description is covered in the Appendix.

4.2 Design Assumptions

EBnet has made the following assumptions, each of which influences the design:

a. The only type of interface with EBnet required by the SCS for WAN data transport is serial clock and data.

b. The data rates to be supported at the SCS/EBnet interface are channelized as follows (Any one of the indicated rates may be present on the line at any given time. However, the data rate on the line may be switched by the source without notice. Therefore, the MUX channel must have the capability to accept data rate changes between the listed frequencies on an automatic basis.):

   1. Telemetry Line 1: 1 kilobit per second (kbps) or 16 kbps, simplex, transmit only at the SCS.

   2. Telemetry Line 2: 1 kbps, 16 kbps, 256 kbps, or 512 kbps, simplex, transmit only at the SCS.

   3. Command: 0.125 kbps, 1 kbps, 2 kbps, or 10 kbps, simplex, receive only at the SCS.

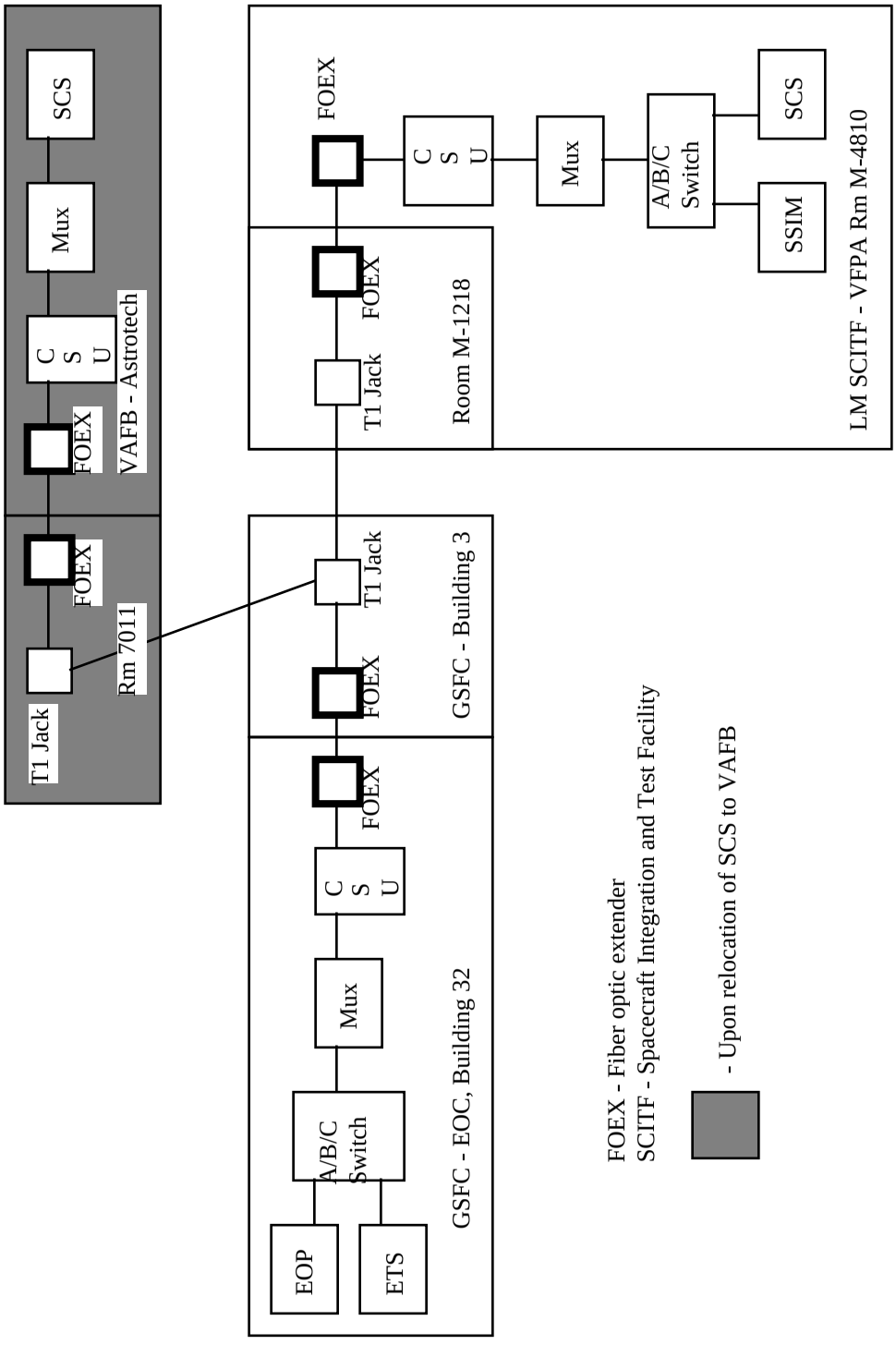

Figure 4-1. End-to-End Circuit Between GSFC and SCS Site Locations

NOTE

Each of the lines will produce or receive clock and data via RS-422 standards over RS-449 interfaces.

c. The SCS will first be located at the contractor's facilities in VFPA. Upon completion of activities there, the SCS and its EBnet communication terminal will be relocated to the VAFB launch site.

d. The SCS requires data communication with the EOC at GSFC.

e. Since EBnet supplies the MUXs for each end of the data link's path, inclusion of the individual modules and the firmware versions to be employed is not required for this ICD.

f. The physical interface for the command signal is a fully compliant RS-449 37-pin D connector.

g. The three data lines must be switchable between one set of interfaces with the SCS and an identical set of interfaces with the SSIM, also located at the LM VFPA facility.

4.3 Data Interface Design

The data signals to be transported will employ a T-1 intelligent time division MUX with AscomTimeplex Corporation being the intended vendor. Because the three data lines to be transported must be capable of being manually switched between either the SCS or the SSIM at the VFPA site, EBnet will include an A/B switch specifically configured to perform this function in its design. VFPA personnel will provide cables to A/B switch from SCS and SSIM.

At the SCS site(s), the EBnet equipment will be mounted in its own equipment cabinet. In the bottom of the equipment cabinet EBnet will provide a (bulkhead) connector interface panel. This connector interface panel constitutes the demarcation point between the SCS and EBnet. EBnet is responsible for the MUX side of the panel. Everything on the SCS side of the panel is an SCS responsibility, including cabling up to the panel.

Because some of the data rates to be supported are custom, the MUX equipment vendor is supplying a special data channel module for transport of the SCS data signal. Reference Section 4.7.

Figure 4-2 provides a representation of the EBnet/SCS interface.

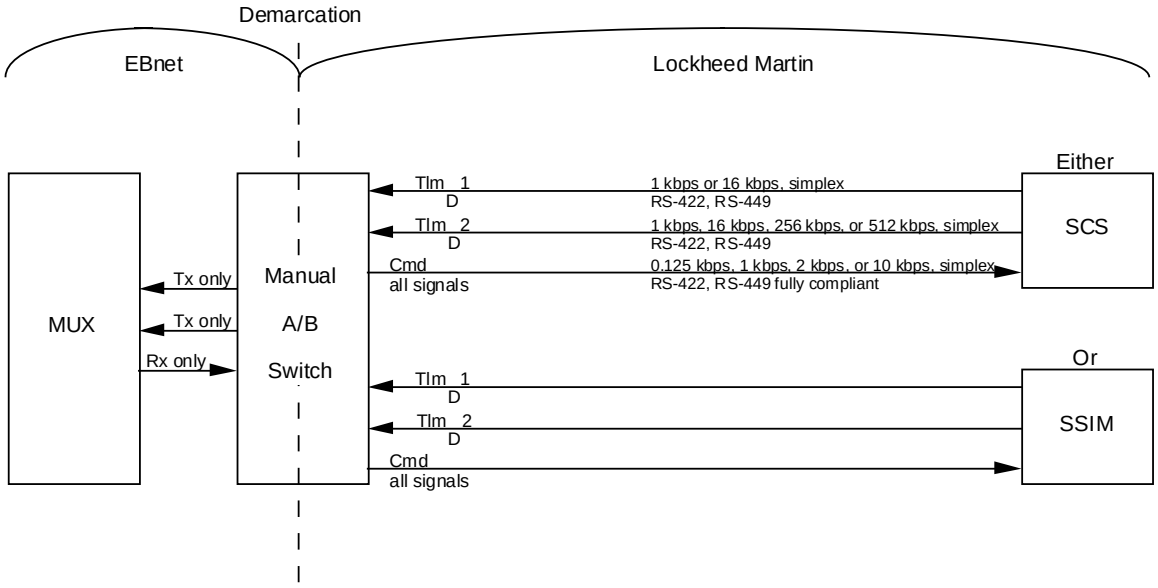

Figure 4-2. EBnet/SCS Interface

4.3.1 Electrical Interfaces

The electrical interfaces between the MUX channel and the SCS shall conform to the Electronic Industries Association's (EIA's) RS-422 standard [5] for each of the three data lines.

4.3.2 Physical Interfaces

For the commands data line, the physical interface between the MUX channel and the SCS shall conform, in all respects, to the EIA's RS-449 standard [6]. For the two telemetry data lines RS-449 connectors are also used.

4.4 Performance

The EBnet/SCS interface shall meet the following performance specifications detailed below.

4.4.1 Data Rates

Data rates to be supported are data line-specific and are stated here.

a. Telemetry Line 1: 1 kbps or 16 kbps, simplex, transmit only at the SCS (assume the interface to be wholly compliant with the RS-449 37-pin D connector option).

b. Telemetry Line 2: 1 kbps, 16 kbps, 256 kbps, or 512 kbps, simplex, transmit only at the SCS (assume the interface to be wholly compliant with the RS-449 37-pin D connector option).

c. Command: 0.125 kbps, 1 kbps, 2 kbps, or 10 kbps, simplex, receive only at the SCS (assume the interface to be wholly compliant with the RS-449 37-pin D connector option).

4.4.2 Timing

The MUXs will be configured to operate on a master (GSFC) - slave (SCS) basis. The communication common carrier will supply the timing signal for system timing.

4.4.3 Restoral

Since this is not a real-time service, the system design will support a MTTRS of 4 hours.

4.5 On-line Configuration Management

The MUX will be operated in the master - slave mode with the master station's functions being performed by GSFC.

4.6 Maintenance and Operation Management

The Timeplex MUX is of a modular architecture. When a failure is diagnosed by the EBnet network management function as being in a module of the SCS MUX, then LM site personnel at the SCS will be asked by the EBnet Network Management Operator to remove the failed module and replace it with a spare. If the fault cannot be resolved by the simple act of module replacement, then the Network Management Operator will dispatch a technician from the servicing vendor.

4.7 Equipment List

EBnet will provide the following equipment to support this interface:

a. Multiplexer: Timeplex (Model Link/2+).

b. RS-449 A/B Switch: South Hills Data Comm.

Section 5. Facilities and Maintenance Demarcation

5.1 Equipment Location

EBnet will interface to the SCS equipment located in Building 100 integration and test Annex at VFPA. EBnet equipment will be located in Room M4810 at a space to be provided. The customer will be responsible for extending link from AT&T smart jack to EBnet CSU (reference Figure 4-1).

5.2 Maintenance Demarcation

The demarcation point between EBnet maintenance and customer maintenance is the connection at the Data Comm A/B Switch. The user is responsible for cables to the EBnet demarcation.

Appendix A. Launch Site Interface

A.1 VAFB Interface Description

The interface between the EBnet communication terminal and the SCS at the launch site remains the same as described in Section 4 of this ICD with the following exceptions: the EBnet communication terminal will no longer be required to switch between the SCS and SSIM workstations, the WAN circuit will now terminate at Room 7011, VAFB Launch Site. EBnet does not intend to remove the A/B switch from its cabinet when the SCS and its EBnet communication terminal are relocated from the VFPA contractor facility to the VAFB launch site. In addition, a new interface is added: a 16 kbps telemetry channel coming from EDOS to the SCS. This channel is used to broadcast the TDRSS telemetry coming from White Sands Complex (WSC). The telemetry data coming from WSC will enter the EDOS low rate matrix switch where it will be broadcast back out to EBnet on this new 16 kbps telemetry channel for delivery to the SCS at VAFB. This allows the personnel at VAFB to view early TDRSS telemetry. This capability is anticipated to be needed for only a short time after launch (approximately one week). Refer to Figure 4-1 which provides a high-level depiction of the end-to-end circuit path between the GSFC/EOC and the Launch Site. Figure A-1 depicts the EBnet communication terminal's interface with the SCS after the move to VAFB.

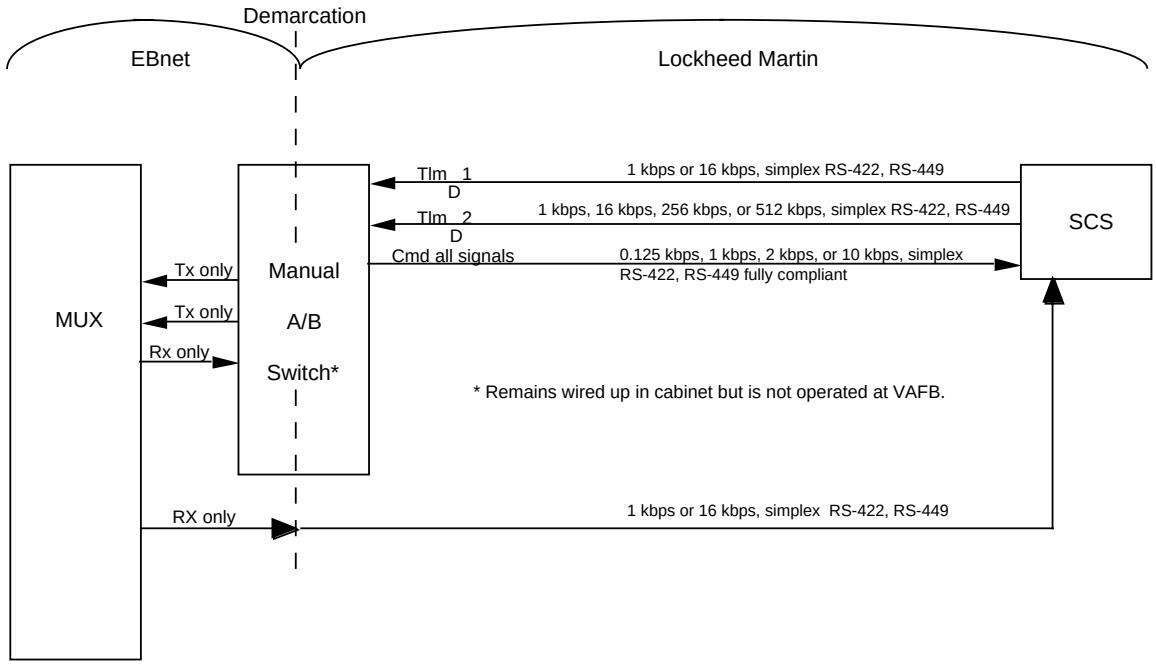

Figure A-1. EBnet/SCS Interface at the Launch Site

A.2 Equipment Location

VAFB site will be responsible for extending link from AT&T smart jack (Room 7011) to the EBnet MUX (near launch pad).

A.3 Maintenance Demarcation

The user is responsible for maintenance between AT&T smart jack and the EBnet MUX, and is also responsible for the cables and equipment leading up to A/B Switch as shown in Figure A-1.

Abbreviations and Acronyms

CCB	Configuration Control Board
CCITT	International Telegraph and Telephone Consultative Committee
COMMGR	Communications Manager
CSMA/CD	Carrier-Sense Multiple-Access with Collision Detection
DCN	Document Change Notice
EBnet	EOSDIS Backbone Network
EDOS	EOS Data and Operations System
EGS	EOS Ground System
EIA	Electronic Industries Association
EOC	EOS Operations Center
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
ESDIS	Earth Science Data and Information System
ETS	EOSDIS Test System
FDDI	Fiber Distributed Data Interface
GSFC	Goddard Space Flight Center
ICD	Interface Control Document
IEEE	Institute of Electrical and Electronic Engineers
IGMP	Internet Group Multicast Protocol
IONET	IP Operational Network
IP	Internet Protocol
IRD	Interface Requirements Document
ISO	International Organization for Standardization
LAN	Local Area Network
LLC	Logical Link Control
LM	Lockheed Martin
MAC	Media Access Control

MO&DSD	Mission Operations and Data Systems Directorate
MTTRS	Mean Time to Restore Service
MUX	multiplexer
NASA	National Aeronautics and Space Administration
Nascom	NASA Communications
NMI	NASA Management Instruction
OSPF	Open Shortest Path First
PHY	Physical Layer Protocol
PMD	FDDI Physical Layer Medium Dependent
PPP	Point-to-Point Protocol
RARP	Reverse Address Resolution Protocol
RFC	Request for Comment
RIP	Routing Information Protocol
SCS	Spacecraft Checkout Station
SNMP	Simple Network Management Protocol
SSIM	Spacecraft Simulator
TDRSS	Tracking and Data Relay Satellite System
VAFB	Vandenberg Air Force Base
VFPA	Valley Forge, Pennsylvania
WAN	Wide Area Network
WSC	White Sands Complex